A Study on Distributed System Management for OSI Environment (OSI環境における分散システムの管理法に関する研究)

著者	朴 勝燮
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氏名	Park Seung Seob 朴 勝 燮
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指導教官	東北大学教授 白鳥 則郎
論文審査委員	東北大学教授 白鳥 則郎　東北大学教授 高木 相 東北大学教授 阿曽 弘具

論文内容要旨

As the size and complexity of network increase, the distributed systems management (DSM) will be significant issue within information network in order to increse the high reliability and to improve the flexibility of network management.

The OSI management model has several problems. The key problems are that it does not fully address the problem of, first, how to define system architecture suitable for distributed management environment, second, how to develop communication protocol in support of DSM, and third, how to classify the management informations. In this thesis, to solve first problem described above, the basic structure of distributed network management system (DNMS) with intelligent facilities for efficient network management is introduced, and especially the concrete design of system management application process which is an important element among them is also given. And to overcome second problem, the connectionless CMIP to accomplish for effectively management the distributed management system is proposed, and indicated its efficiency ; this protocol is available to negotiate among the management system, to handle the dynamic informations. To work out third problem, the connection criteria in the hierarchy of management systems is illustrated, the conventional centralized systems management with the proposed distributed systems management is

compared, and finally evaluated the efficiency of a suggested protocol during cooperative negotiation among the management systems. This thesis consists of five chapters. Each chapter is described in detail as follow :

In Chapter 1 ' Introduction', the motivation and objectives of this thesis is described. The necessity of DSM is discussed to accomplish for effectively managing the distributed system. The distributed management problems will be aggravated by the facts that the network will consist of a diverse network equipment, networking services provided by different carriers, and new introducing technologies. To ensure all network resources internetwork correctly and effectively, high-reliable and distributed management will be needed in information network environment which can be managed.

By this reasons, the DSM of the distributed processing environment will provide the great potential benefits. The main objectives in moving to a distributed systems management are described : Flexibility and extensibility, A vailability and integrity, High-Reliability and intelligence, Local controlling and performance, etc. And the organizations of this thesis is also described.

In Chapter 2 ' Distributed System Management (DSM) Environment', the definitions of terminologies used in this thesis are described, and the DSM's model which is suitable for presenting the direction of future management system is shown in chapter 2. 2.

In chapter 2. 3, the brief explanation of elements needed for systems management of information network is given, and the basic structure of distributed network management system (DNMS) with intelligent facilities for efficient network management is proposed. To accomplish full DSM environment, the general four requirements for system management in distributed environment is also described : User Interface Level, OSI Management Communication level, Management Data Level, Management Functions Level.Only few of today's management system tools for network are truly integrated in these four levels. The results of full DSM can be reduced skill level needs for network users, reduced errors in managing multiple networks, and increased network management flexibility.

In chapter 2. 4, the concrete design of system management application process (SMAP) which is an important element among them is shown in this chapter. In this architecture, it consists of four modules : Monitor, Counselor, Management Knowlege Base (NKB), Network Information Base (NIB). Monitor is the major part of SMAP performing management tasks and coordinate all the components. This module has four major functions : MIB access facilit ies, Classifying function for distinguish among networl enities, Assigning priprity to each request, Decision of management function module according to the received informations, etc.

Counselor is an expert systems performing the five management functionalities defined by

OSI management : Configuration Management : Configuration Management (CM), Fault Management (FM), Performance Management (PM), Accounting Management (AM), SecurityManagement (SM). Each expart system built for different domain requires the different knowledge bases named Management Knowledge Base (MKB) which stores the required knowledge, and it is available for consultation when a counselor receives a request from Monitor. It collaborates on a work with Monitor in order to offer recommendations. It provides appropriate recommendations to the Monitor by using the offered information.

This counselor works on MKB which consists of the global database in which a description of a problem is stored and the solution to the problem evolves, and the set of rules contains the general knowledge about a problem area.

A MKB stores the knowledge necessary to solve problems in the five specific domains described previously. This knowledge is represented in a several ways, such as, frame model, semantic model network, production model.

This thesis recommended the production model to represent the knowledge with cause-and-effect property since it is very popular, suitable for implementation. Using this DNMS (Sub-Manager) model, it can be solved that much of the management problems which is experienced in distributed networks. It is also able to reduce the expertise needed to control and monitor the network. The Monitor has an Network Information Base (NIB) to store also includes the translation rules of data representations, commands to deal with heterogeneous systems interaction. And as the size of networks increases, a scheme for name management is needed in order to name network resources.

In Chapter 3 ' Managenent Protocols For DSM Environment ', several typical protocols which are widely used for systems management is illustrated inchapter 3 . 2 ; there are several typical protocols which are widely used for systems management, e. g., Simple Network Management Protocol (SNMP), Common Management Information Protocol over TCP／IP (CMOP) , and Common Management Information Protocli (CMIP), etc.

They may be, roughly, classifies as two types protocols in views of management models. In event-driven basic protocol, for example, CMIP／CMOT, the manageed systems only sends informations to the managing system in case of need to report the occurred events. On the other hand, polling-driven basis protocol, for example, SNMP, is used when managed systems are polled for certain information and return this information synchronously to the managing system. And the necessity of connectionless management protpcol to achieve truly distributed management enviornment is described. CMIP is an association-oriented protocol while SNMP is connectionless. Two CMIP application entities can exchange management operational messages. only if they set up and maintain an association with each other (i. e., an OSI association). SNMP application entities directly send messages to each other ; they

do not need to first establish and then maintain application level connections, as a prerequisite to operational communications. During network stress time, connections may not be sustainable over sufficiently long time to accomplish the management functions needed. Management entities may need to spend significant time and resources in handling lost connections. The connection-based transport may be become an obstacle in accomplishing management interactions at a time when they are needed most.

The development of distributed systems management is unlikely to occur without the standrds in the area of managing system to managing system (i. e., Manager-Manager) interaction which have not yet defined by ISO/IEC. The management systems are view as peer applications that use the services of a common management information service element (CMISE) to managed information. The CMISE provides service access points (SAPs) to support controlled associations between managing system and managing system. Associations are used to exchange managed information queries and responses, handle event notifications, and provide remote invocations of management system operations. CMISE utilizes the services of OSI's association control service element (ACSE) and the remote operations sevice element (ROSE) to support these services.

Here we want to point out that there should increase a demand for broadcasting management protocols to achieve truly distributed management environment. Intrinsically, CMIP is connection-oriented protocol. It is not so suitable for broadcasting, mainly due to the enormous information overhead resulted from message replications, as a prerequisite to operational communication.

But the large networks, e. g., WAN, ISDM, ATM networks, radio and satellite network, et c., must be taken to adopt CMIP in point of number managed systems even if very large information overhead, because this protocol is an event-driven basis scheme.

And also, considering that future management systems will be extended to OSI-based management implemetations, there will be necessary to study a connectionless CMIP to accomplish the large scaled DSM environment, which this environment may by dynamically changing due to additions and deletions of managing systems.

We will restric our discussion only on connectionless CMIP suitable for dynamic chaging distributed environment. The service primitives of connectionless CMIP are presented in chapter 3. 3 for negotiation process among DNMSs.

In chapter 3. 3, the connectionless CMIP to accomplish for effectively managing the distributed management system is proposed ; this protocol is available to manage dynamically changing DSM environment, to negotiate among the managing systems, to handle the dynamic informations. A cooperative negotiation process for management activitied among DNMSs is described as following scenario : executes autonomously independent of other DSMs

under normal conditions ; If the DNMS are overloaded in a certain, it may broadcast the request messages to another DNMSs to be supported ; The DNMS to be requested (we call them responder herefter) from overloaded DNMS replys to the requesting DNMS which is overloaded (also call requester) about its load state if the requester's requests are executable ; The requester can distribute its workload to the most available responder with most lightly load state in disregard of no replying responders due to failures, etc. And the services of proposed protocal is proposed : Support Announcement Service, Announcements Evaluation Service, Degree Of Demand Evaluation Service, Predicting Execution Service, Awards processing Service. And the processing of each service is also given in this chapter.

In Chapter 4 ' Evaluation And Discussion', In chapter 4. 2, the connection criteria among management systems according to five values to the hierarchy of management system proposed is ollustrated. Here the management informations of managed objects which monitored by agents is classified, and also is divided into two cases according to the property of management information, i. e., static informations, dynamic informations. At results the ideal management environment in the hierarchy of management system is proposed. And the OSI network management model (i. e., centralixed system management) with proposed network management (i. e., distributed system management) by explaining the advantage one by one is compered, the proposed network management (i. e., distributed system management) will be more efficient than OSI network management model, and without distributed system management, the efficient network management will not be expected in future network management though it exists disadvantages.

The distributed systems management will be significant for management the future diverse networks as compared with conventional method though it exists disadvantages. And the behavior of a DNMS modules during negotition also illustrated.

In chapter 4. 3, the descriptive evaluation to present the availability of proposed protocol is discussed, justified it. This proposed connectionless CMIP facilitates the distributed control of cooperative management workload execution with efficient negotiation among DNMSs in OSI management environment.

In chapter 4. 4, we analyzed and estimated the utilization of transmission medium of managing system distributed environment in case of using two transmission techniques, i. e., token passing, CSMA/CD. In case of implementing the distributed system management in local network, we concluded that the token passing technique is more better than CSMA/CD technique under such circumstance that the number of managing system is larger.

In Chapter 5 ' Conclusions', the contents of all chapters are summarized.

The distributed systems management (DSM) will be significant issue within information network in order to increase the high reliability and to improve the flexibility of network

management. The conventional OSI management model has several problems.

The key problems are that it does not fully address the problem of how to define system architecture suitable for distributed management environment, how to develop communication protocil in support of DSM, and how to classify the management informations.

The contribution of this thesis can be described as follows :

In chapter 2 , to solve first problem described above, this research introduced the basic structure of distributed network management system (DNMS) with intelligent facilities for efficient network management, and also especially gave the concrete design of system management application process which is an important element among them.

In chapter 3 , to overcome second problem, this research proposed the connectionless CMIP to accomplish for effectively managing the distributed management system, and indic ate its efficiency ; this protocol is available to negotiate among the managing system, to handle the dynamic informations.

In chapter 4 , to work out third problem, this paper introduced the connection criteria in the hierarchy of management systems, compared the conventional centralized system management (i. e., OSI network management) with the proposed network management (i. e ,distributed system management) by explaining the advantages one by one. We concluded t hat the proposed network management will be more efficient than OSI network management model, and without distributed system management, the efficient network management will not be expected in future network management.

And the efficiency of a suggested protocol during cooperative negotiation among the managing systems is evaluated. Finally this research analyzed and estimated the utilization of transmission medium of managing system in distributed environment in case of using two transmission techniques. In case of implementing the distributed system management in local network, this research concluded that the token passing technique is more better than CSMA /CD tecnique under such circumstance that the number of managing system is larger.

This dissertation supports that the proposed structure of DNMS, the concrete design of system management application porcess which is an important element among them, and the proposed connectionless CMIP are most useful for distributed systems management environment.

審 査 結 果 の 要 旨

情報通信システムなどの分散システムの大規模化と複雑化に伴い，その統一的かつ効果的な運用のためのシステム管理法が，極めて重要な課題となっている。しかし，現状では，このような課題を解決するための有効な方法論や技術は十分には確立されていない。そこで，著者は，分散システムの管理法について詳細な研究を行い，効果的な管理モデルとプロトコルを構成しその有効性を示した。本論文はその成果をまとめたものであり，全編5章よりなる。

第1章は序論である。

第2章では，分散システムにおけるネットワークの効果的な管理法について論じ，従来の集中型の限界を明確化した。また，OSI管理モデルのように単一のマネジャが管理する従来の集中型に対し，新しく階層化に基づく分散型の管理法を提案し，その基本的なモデルを構成した。このモデルの基本概念は，管理の対象となるネットワークを複数のサブネットワークに分割し，サブネットワーク毎にサブマネジャを導入し，管理の分散化によりシステムの高信頼化，高効率化を達成するという考えに基づいている。これは，従来のＯＳＩ管理モデルと比較した大規模で複雑なシステムのための有用なモデルである。

第3章では，第2章で提案したモデルに基づいた分散型の管理システムについて検討し，特に複数の分散したサブマネジャから成る階層化に基づく分散型管理システムを構成した。また，分散システムを効果的に管理するためにサブマネジャ間において必須とする情報交換の機構を明確化し，これに基づいてサブマネジャ間の基本プロトコルを提案した。これは分散システムを効果的に管理するために必要なプロトコルの基本的な機構を明らかにしたもので重要な成果である。

第4章では，階層化の概念に基づいた分散型管理システムにおける管理プロトコルについて詳細に論じている。特に，従来のOSI管理モデルと比較を行い，性能評価により，効率や信頼性の点から提案した管理プロトコルの有効性を示している。

第5章は結論である。

以上要するに，本論文は分散システムの管理法について効果的な管理モデルとプロトコルを構成し，高度な情報通信システムの構成のための有用な知見を与えたものであり，情報工学及び通信工学の発展に寄与するところが少なくない。

よって，本論文は博士（工学）の学位論文として合格と認める。